tials from sensory hair remained unaffected. We do not know why there is an apparently negative correlation between the toxicity, i.e., LD₅₀, of the pyrethroid and its ability to elevate tarsal threshold, i.e., ED₅₀.

Carbamates are "centrally acting" insecticides which tend to produce convulsive bursts of variable length separated by relative inactivity (MILLER and ADAMS, 1977). This inactivity may be linked to the inhibitory action on tarsal responses of the carbaryl-treated housefly.

REFERENCES

- BAILLIE, A. C. (1985) *Recent Advances in the Chemistry of Insect Control* (N. F. JANES, ed.). The Royal Society of Chemistry, London, pp. 16-31.
- BURT, P. E., K. A. LORD, J. M. FORREST and R. E. GOODCHILD (1971) *Entomol. Exp. Appl.* **14**: 255-269.
- BURT, P. E. and R. E. GOODCHILD (1971) *Entomol. Exp. Appl.* **14**: 179-189.
- BUSVINE, J. R. (1957) *A Critical Review of the Technique for Testing Insecticides*. Commonwealth Institute of Entomology Publication, London, pp. 171-179.
- CHADD, E. M. and J. BRADY (1982) *Physiol. Entomol.* **7**: 133-141.
- CLEMENTS, A. N. and T. E. MAY (1977) *Pestic. Sci.* **8**: 661-680.
- DETHIER, V. G., R. L. SOLOMON and L. H. TURNER (1965) *J. Comp. Physiol. Psychol.* **60**: 303-313.
- DETHIER, V. G. (1976) *The Hungry Fly*. Harvard University Press, Cambridge, Massachusetts.
- HOLAN, G., B. J. POPPLETON, T. H. SPURLING and C. T. VIRGONA (1980) *Insect Neurobiology and Pesticide Action* (Neurotox 79). Society of Chemical Industry, London, pp. 73-78.
- KAISLING, K. E. (1980) *Insect Neurobiology and Pesticide Action* (Neurotox 79). Society of Chemical Industry, London, pp. 351-358.
- MILLER, T. A. and M. E. ADAMS (1977) *Synthetic Pyrethroids* (M. ELLIOTT, ed.). American Chemical Society Symposium Series **42**, Washington, pp. 98-115.
- SHARMA, R. N. (1969) An enquiry into the nature of resistance mechanism(s) against the insecticide dieldrine by comparing its effects on various physiological and behavioural process of susceptible and resistant houseflies. Ph.D Thesis, Delhi University, Delhi.
- SHARMA, R. N. (1973) *Entomol. Exp. Appl.* **16**: 157-164.
- SMYTH, T. Jr. and C. C. ROYS (1955) *Biol. Bull.* **108**: 66-76.
- SOLIMAN, S. A. and L. K. CUTKOMP (1963) *J. Econ. Entomol.* **56**: 492-494.

Control of *Epinotia granitalis* (Lepidoptera: Tortricidae) with *Paecilomyces* spp. on Cotton Bands Wrapped on the Trunks of *Cryptomeria japonica*¹

Wataru MITSUHASHI, Mitsuaki SHIMAZU
and Hoshimi HASHIMOTO

Forestry and Forest Products Research Institute,
P.O. Box 16, Tsukuba Norin Kenkyu Danchi-nai,
Ibaraki 305, Japan

(Received July 20, 1991)

(Accepted December 11, 1991)

Key words: *Epinotia granitalis*, *Paecilomyces*, *Cryptomeria japonica*

Larvae of *Epinotia granitalis* (Lepidoptera:

Tortricidae) attack the phloem of Sugi (*Cryptomeria japonica*) and Hinoki (*Chamaecyparis obtusa*), and are becoming increasingly serious pests. Spraying of chemical insecticides, trimming or thinning, and planting of resistant races of *cryptomeria* have been attempted as control methods, but have not always been effective in the field. Development of effective control methods are still needed.

Two species of fungal genus *Paecilomyces* (YAMAZAKI and KURANAGA, 1988) and a nuclear polyhedrosis virus (MITSUHASHI and SHIMAZU, 1988) were discovered to be *E. granitalis* pathogens. We have confirmed these agents as virulent to the larvae of this insect in the laboratory (unpublished), and have suggested the possible use of these pathogens for the control of *E. granitalis*. Infecting larvae with fungi under coverings on the trunk of *cryptomeria* appears promising because the larvae

¹ Appl. Entomol. Zool. **27** (2): 295-296 (1992)

Table 1. Number and mortality of *Epinotia* in cryptomeria stands

Fungus species applied	Number of trees treated	Number of feeding-traces by <i>Epinotia</i>	Number of <i>Epinotia</i>			
			total	alive	dead	
					killed by fungus	others
<i>Paecilomyces</i> sp. F594	15	57	23	6	14	3
<i>Paecilomyces fumosoroseus</i> F595	15	38	31	0	23	8
Control	15	28	5	4	0	1

have a tendency to aggregate under the covers (YAMAZAKI et al., 1986). Similar control methods were reported to be effective for other insects; *Semanotus japonicus* (Coleoptera: Cerambycidae) with *Beauveria brongniartii*-contaminated polyurethane foam sheets (SHIBATA and HIGUCHI, 1988) and *Dendrolimus spectabilis* (Lepidoptera: Lasiocampidae) with *Beauveria bassiana*-contaminated straw mats (KATAGIRI et al., unpublished).

Two fungal isolates used in this study were *Paecilomyces fumosoroseus* F-595 and an unnamed *Paecilomyces* sp. F-594, both isolated from *E. granitalis* collected at the Tsukuba mountain range, Ibaraki Pref., Japan. The conidiogenous structure and morphological characters of the latter fungus will be described in another paper (SHIMAZU and HUMBER, unpublished). The fungi were cultured by shaking in Sabouraud's dextrose broth with 1% (w/v) yeast extract for 5 days at 25°C. Absorbent cotton bands of ca. 10×50 cm were soaked into the resulting suspension of hyphal bodies of each fungus. The cotton bands were then placed at 25°C under a long day condition for 3 weeks to allow conidia formation on their surfaces.

The bands with fungi (approximately 1.5×10^6 conidia/1×1 cm absorbent cotton) were introduced into an experimental forest of cryptomeria (planted in 1964, 27 y old) at Tsukuba on May 6, 1988. The introduction was made by wrapping a cotton band on a trunk of cryptomeria at breast height. Cotton bands without fungus were applied for controls plot in the same manner. Fifteen trees were wrapped for each plot.

All insects in and under the cotton bands were collected to check mortalities 39 days after the application. The cadavers collected were placed

in moistened chambers to form conidia for identification of fungi.

As shown in Table 1, a considerable number of the larvae of *Epinotia* were killed by the introduced fungi. The mortalities of *Epinotia* were 61% from *Paecilomyces* sp. F594 and 74% from *P. fumosoroseus* F595, and 0% in the control plot. The number of insects collected were relatively small in the control plot. This probably reflects the number of the originally existing insects indicated by the number the feeding traces in the control plot which were fewer than those of the treatment plots.

The result shows a considerably high infection rate of *Epinotia* by this method, although there were originally less insects in the control plot. The method of fungal application we used appears to be an effective control in cryptomeria stands. The possibility remains that some larvae which do not slip into or touch the cotton bands will escape the effect of the fungi.

REFERENCES

- MITSUHASHI, W. and M. SHIMAZU (1988) *Trans. 40th Meet. Jpn. For. Soc. Kanto* (S. NAGUMO, ed.), Jpn. For. Soc. Kanto, Kukisaki, Ibaraki, Japan, pp. 193–194 (in Japanese).
- SHIBATA, E. and T. HIGUCHI (1988) *Appl. Entomol. Zool.* **23**: 199–201.
- YAMAZAKI, S., K. FUKUYAMA, K. Ozaki and O. MAGARISAWA (1986) *Trans. 38th Meet. Jpn. For. Soc. Kanto* (S. NAGUMO, ed.), Jpn. For. Soc. Kanto, Kukisaki, Ibaraki, Japan, pp. 171–172 (in Japanese).
- YAMAZAKI, S. and Z. KURANAGA (1988) *The Ecology and Control of Epinotia granitalis*. Forest Development Technological Institute, Tokyo, 68 pp. (in Japanese).